Chromaticity/Emittance Issues

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- Chromaticity at Injection and Storage
- Chromaticity during the ramp and Feedback
- Transverse Emittance (IPMs)
- Summary

Chromaticity

- Chromaticity causes tune varations with momentum

$$\Delta\nu = \xi_1 \frac{\Delta p}{p} + \xi_2 \left(\frac{\Delta p}{p}\right)^2 + \xi_3 \left(\frac{\Delta p}{p}\right)^3 + \ldots$$

- Momentum variation is determined by the radial beam shifts:

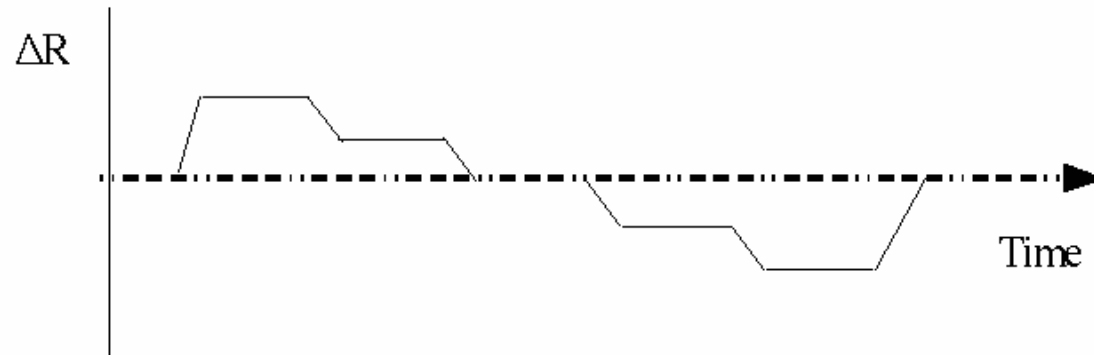$$\frac{\Delta p}{p} = \alpha \frac{\Delta R}{R}$$

- Where α is the momentum compaction factor:

$$\alpha = \frac{1}{\gamma_T^2}$$

- With γ_T being the gamma-transition of the lattice.
    - *Can be obtained from the model engine.*

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Chromaticity

- Measure chromaticity at injection and/or flattop using ARTUS.

- Can also use PLL if active during measurement.

- Number of steps and maximum radial shift is adjustable.

- Fit the measured tunes vs momentum to a polynomial.

- This is a destructive measurement.

- At flattop, the beams must be uncogged and no 200 MHz cavities.

Chromaticity Application

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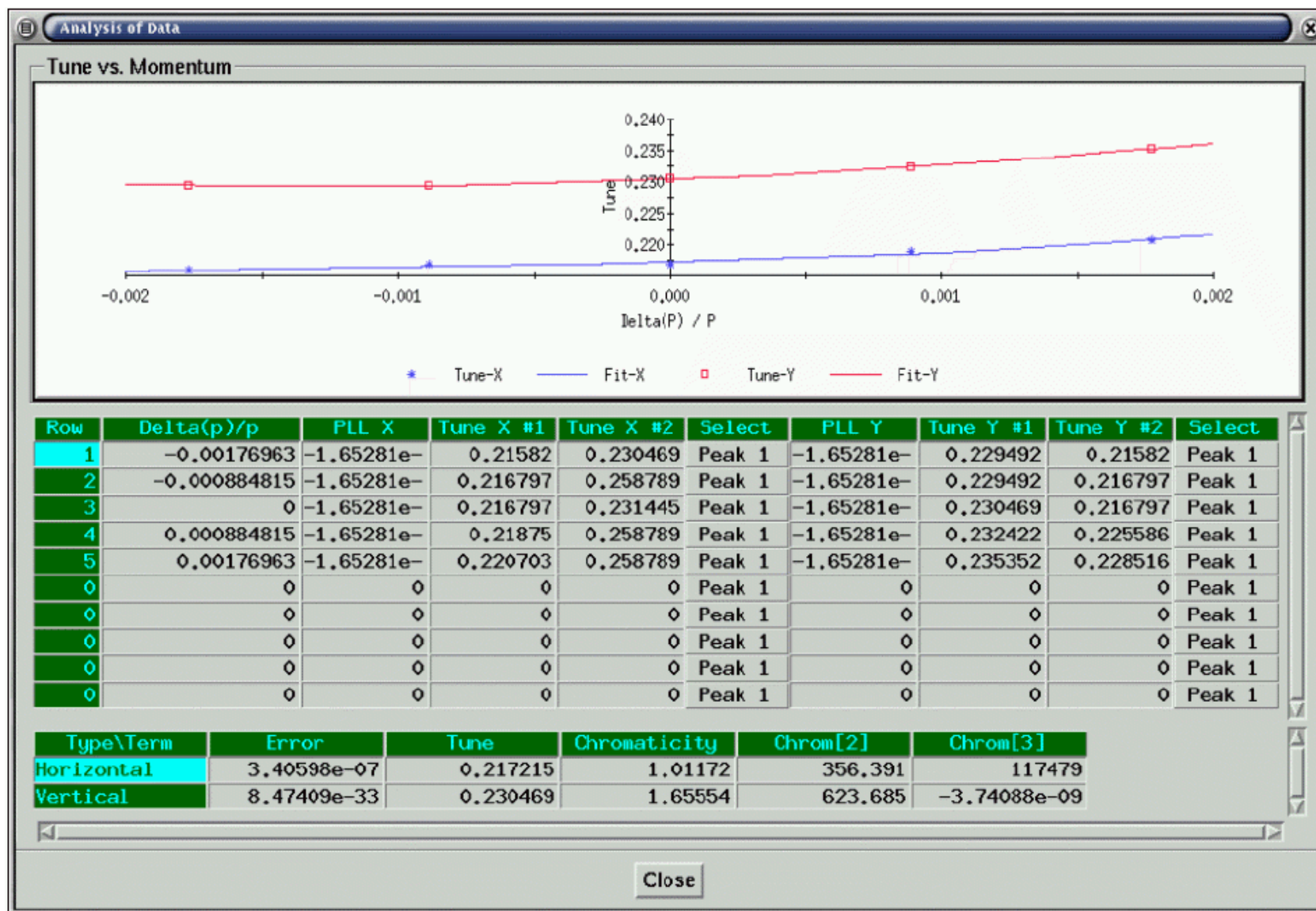
Chromaticity

- Use the PLL tunemeter to measure the tunes
    - *Standard deviation of noise: 2×10^{-4} horizontal, 0.8×10^{-4} vertical*
    - *Data returned with 70 Hz rate*
    - *With tune feedback on, data signal delayed, including amplitude factor*

- Use a small radial jump, ≈ 0.2 mm, in 1 Hz sine wave.

- Calculate the chromaticities by sliding the data along at 70 Hz rate.

- Include error estimates for the chromaticities.

- Feedback the chromaticities to correct the sextupoles, weighted by errors.

- At start of ramp, $\Delta\gamma$ change is largest in 1/2 sec (snapback)

Radial shift [mm] vs. Time [s]
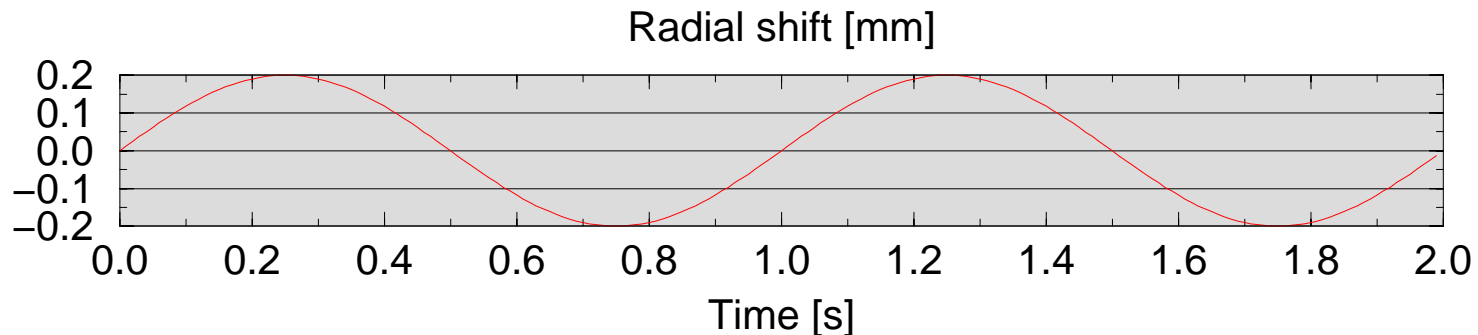
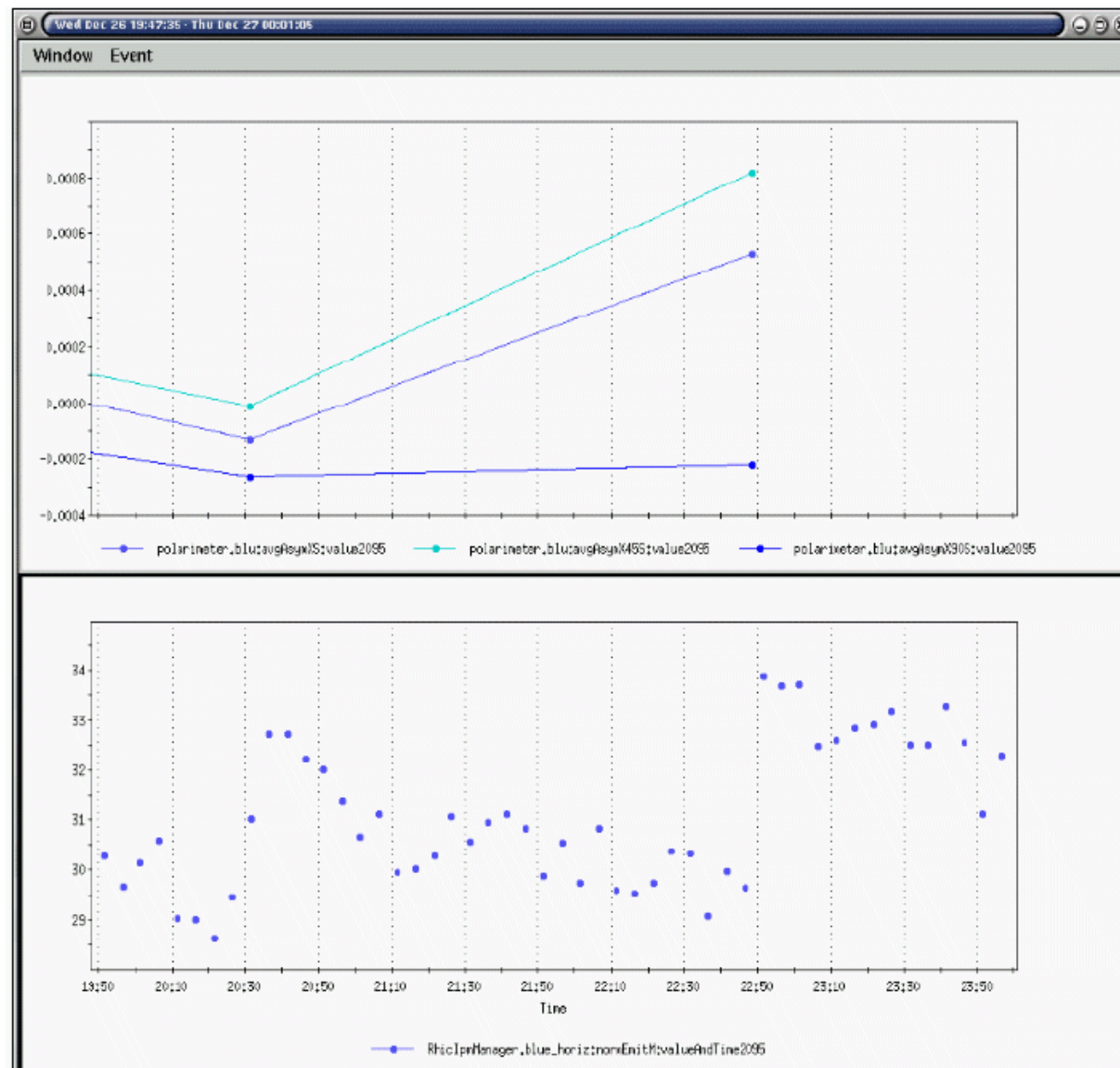# Chromaticity Radial Modulation Data

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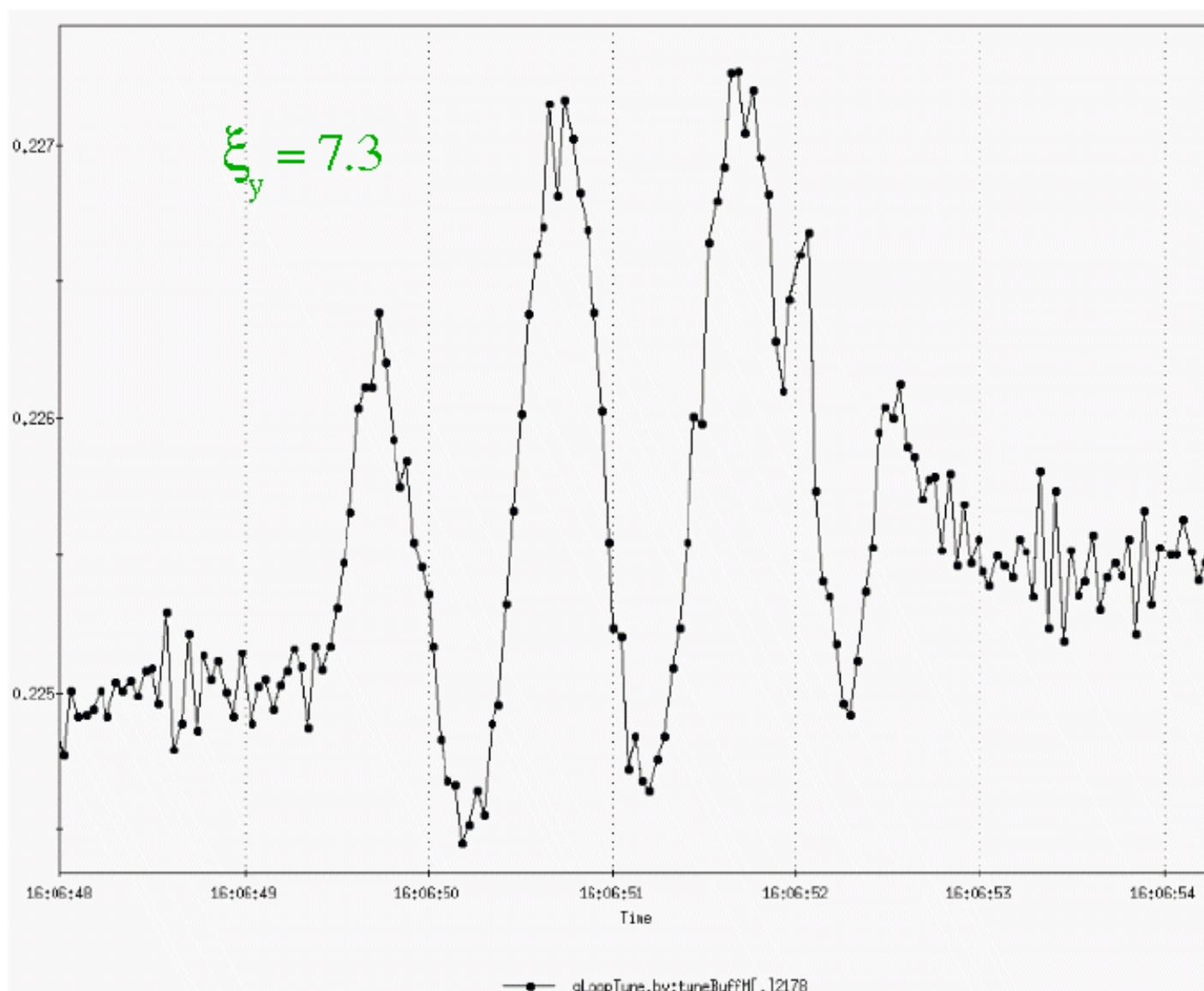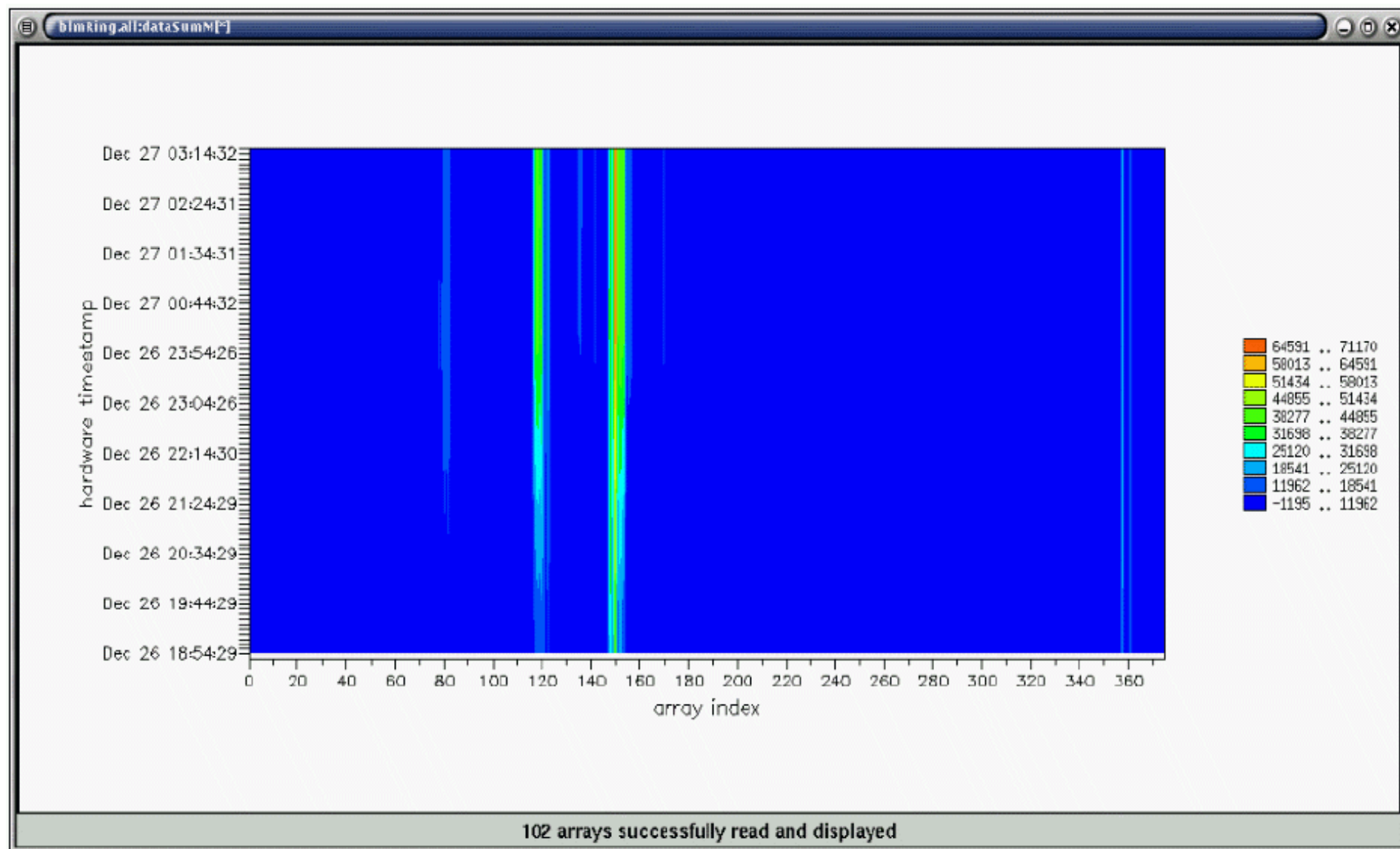
Emittance and IPMs

- Measured emittance sometimes larger than expected at storage
  - *Improved gaussian fitting of profiles this run*
  - *Horizontal IPMs at small β function locations*
  - *Need to fix some dead channels*
  - *Improve data synchronization as saved by logger system*

- IBS measurements were made with both Gold and Proton beams

- A good diagnostic for beam effects
  - *Drops in emittance may be due to beam scraping*
  - *Jumps in emittance can be traced to beam kicks*

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Emittance Growth Data

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BLM ring dataSumM data

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Summary

- A tool is provided to measure and correct chromaticities at injection and flattop

- Developing a tool to measure and correct chromaticites on the ramp using the PLL tunemeter
    - *Initial test to measure chromaticity on the ramp are encouraging*
    - *Requires improvements in PLL tunemeter system*

- Other methods to measure the chromaticity are being considered
    - *Chromaticity from decoherence data, etc.*

- Emittance measurement with IPMs provided a good diagnostic tool on beam performance